Mapping Ambient Pollution Gradients Using Mobile Air Quality Data

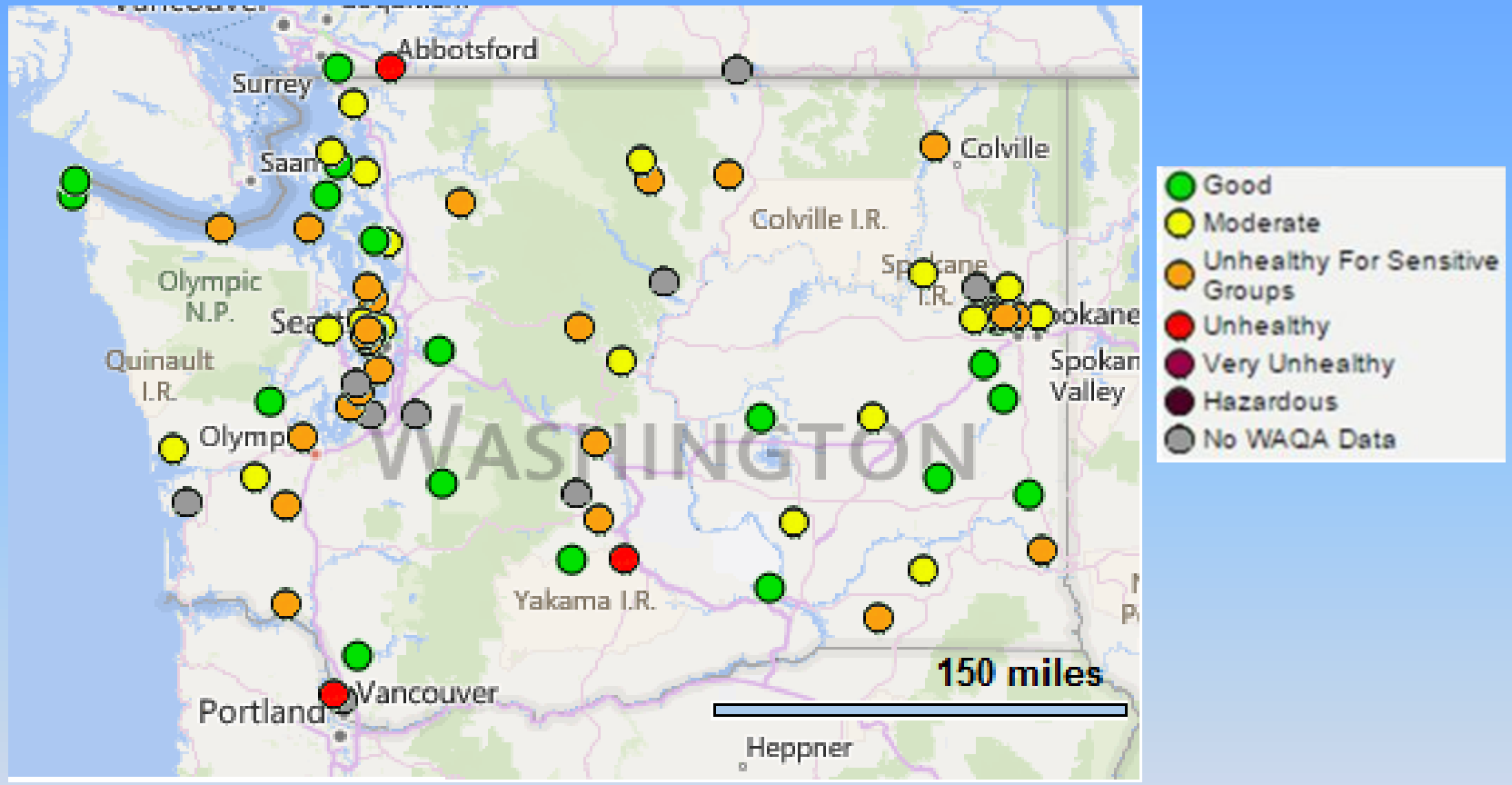
Washington State GIS Day

Jill Schulte, MPH
Quality Assurance Specialist/Data Analyst
Air Quality Program

November 19, 2014

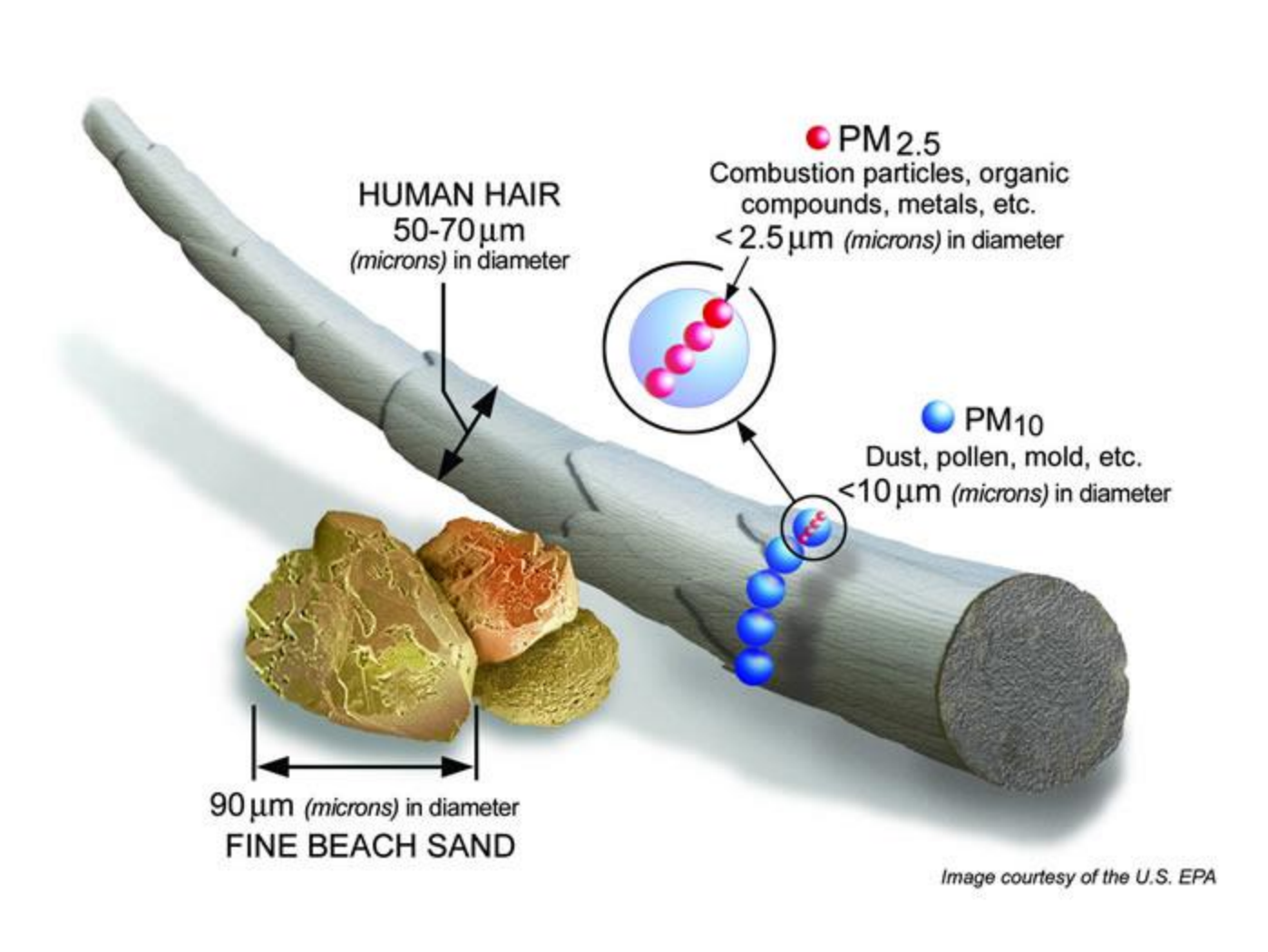
DEPARTMENT OF ECOLOGY
State of Washington

Statewide Air Monitoring Network



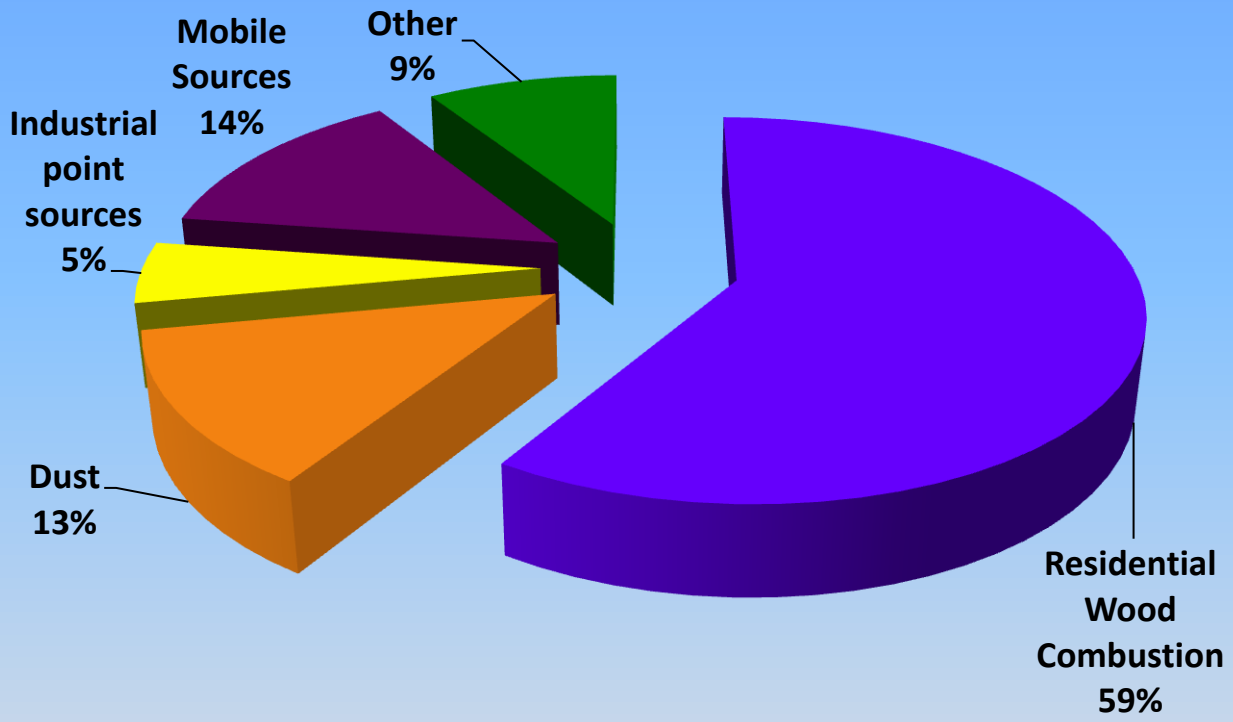
https://fortress.wa.gov/ecy/enviwa/ 10:00am 11/17/14

What is $PM_{2.5}$?



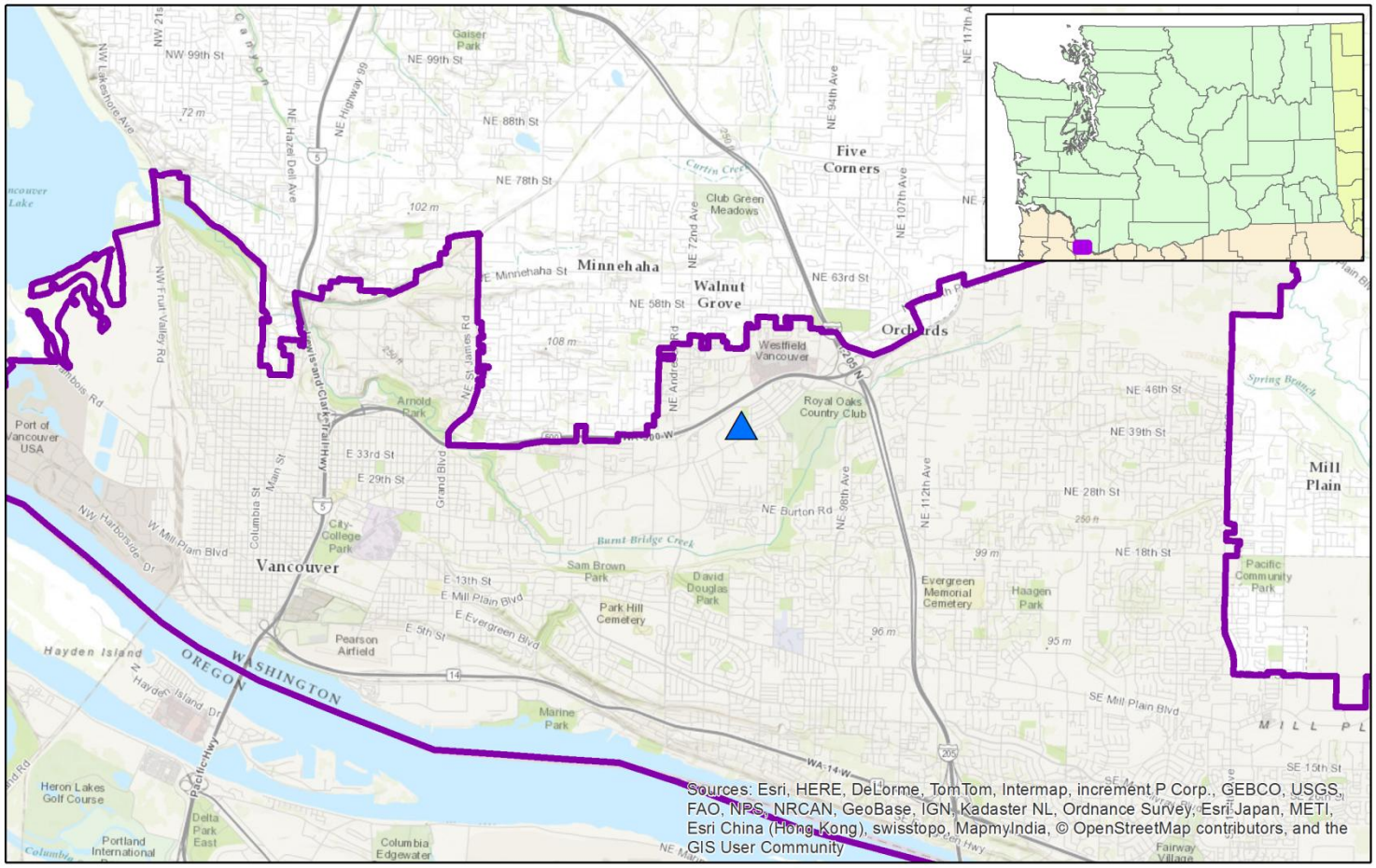
Particulate Matter <2.5 micrometers (µm) in diameter

Winter Sources of $PM_{2.5}$



Neighborhood-Scale Air Quality Monitoring

Vancouver Monitoring Site



State and Local Monitoring Sites

Vancouver City Limits

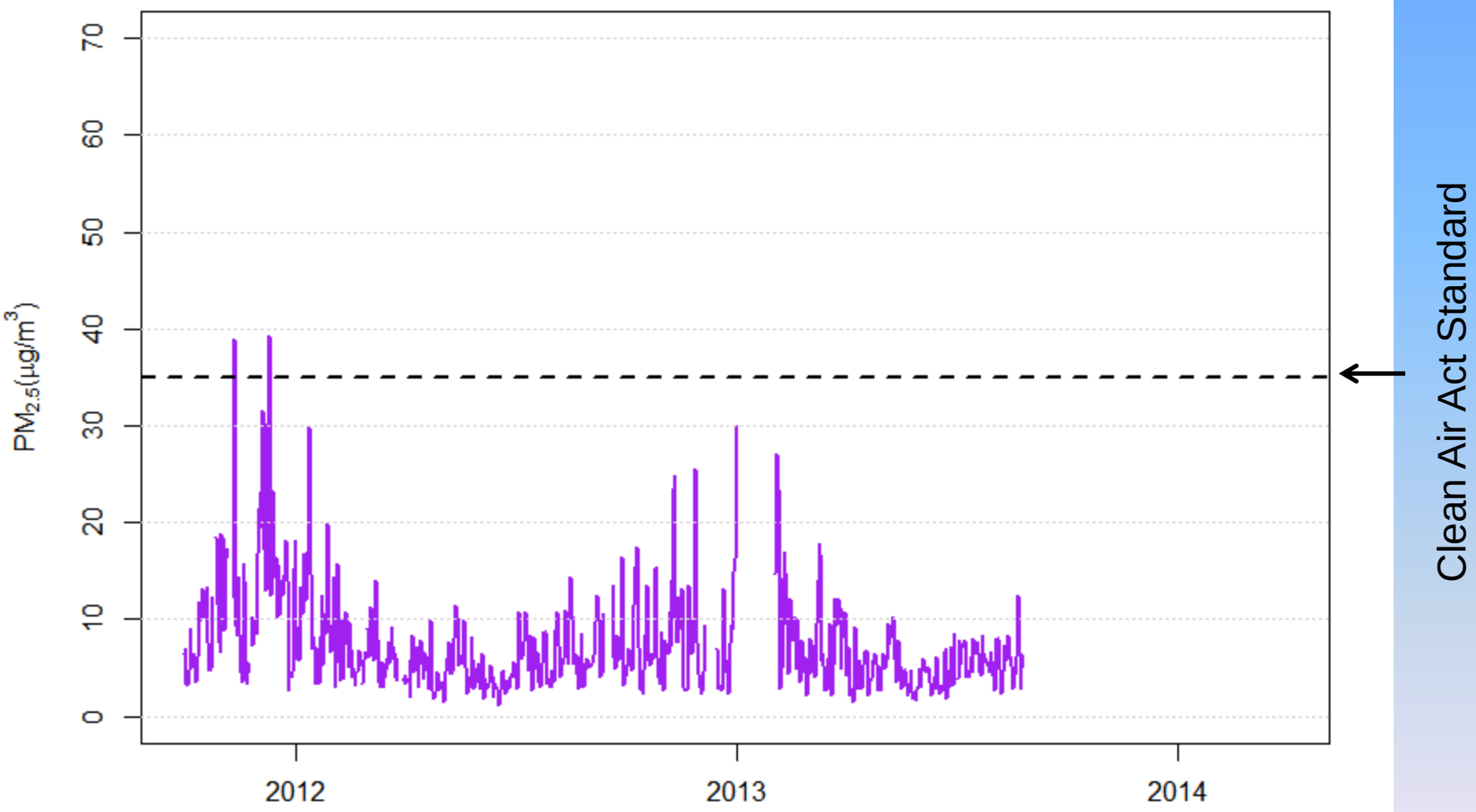
N

0 0.45 0.9 1.8 2.7 3.6 Miles

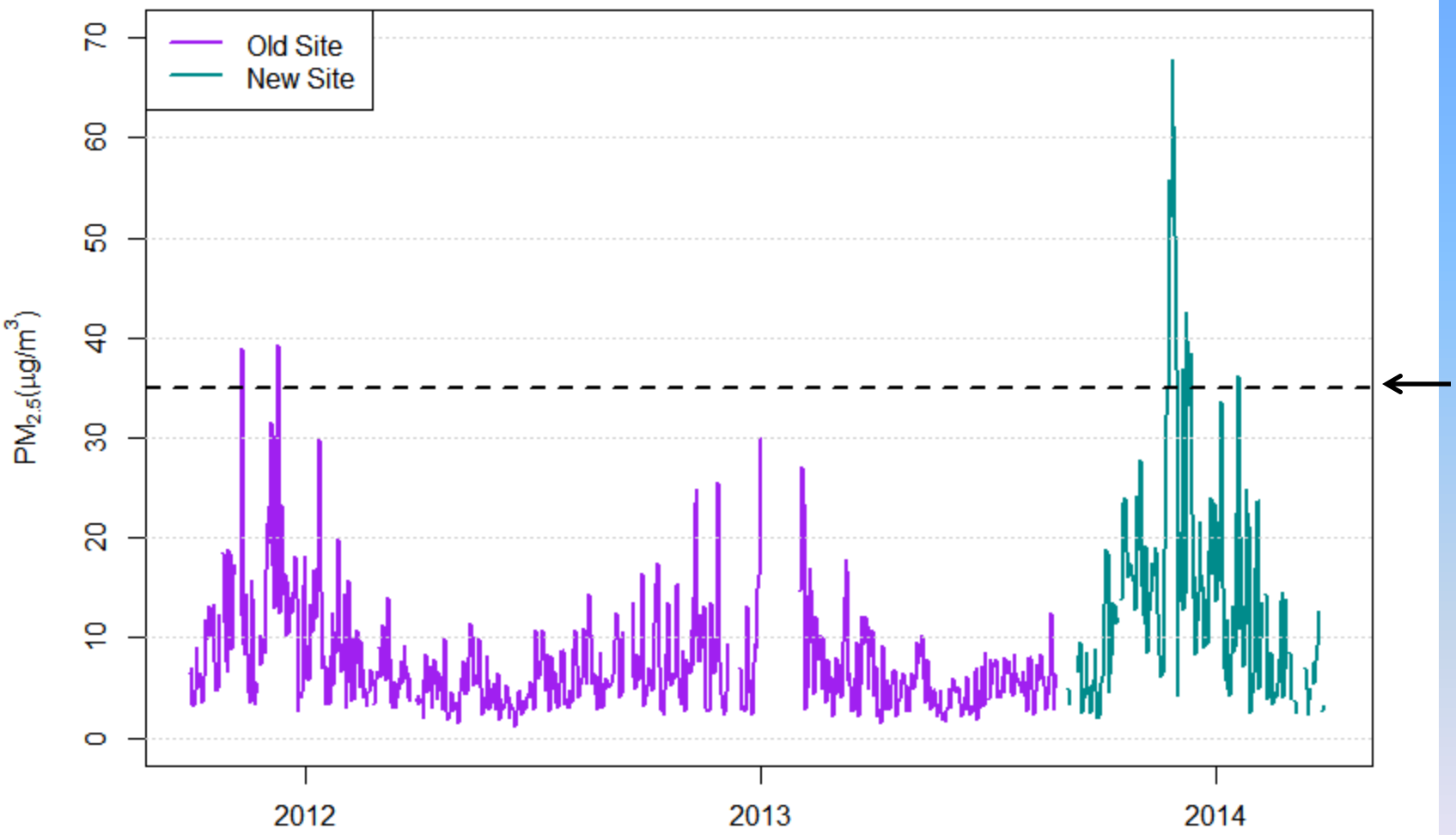
11/18/2014

Vancouver Sites Map

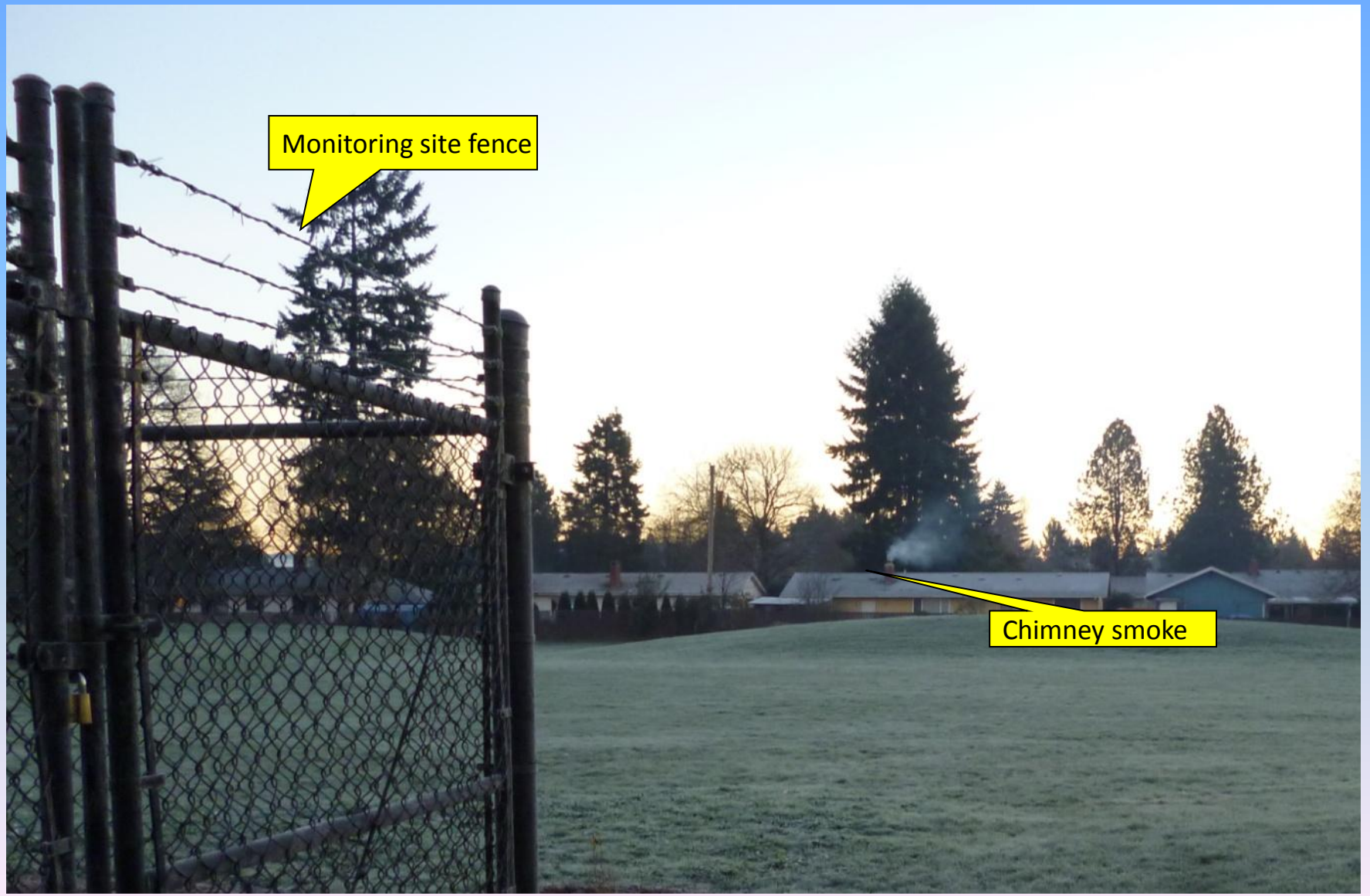
Vancouver $PM_{2.5}$ Concentrations



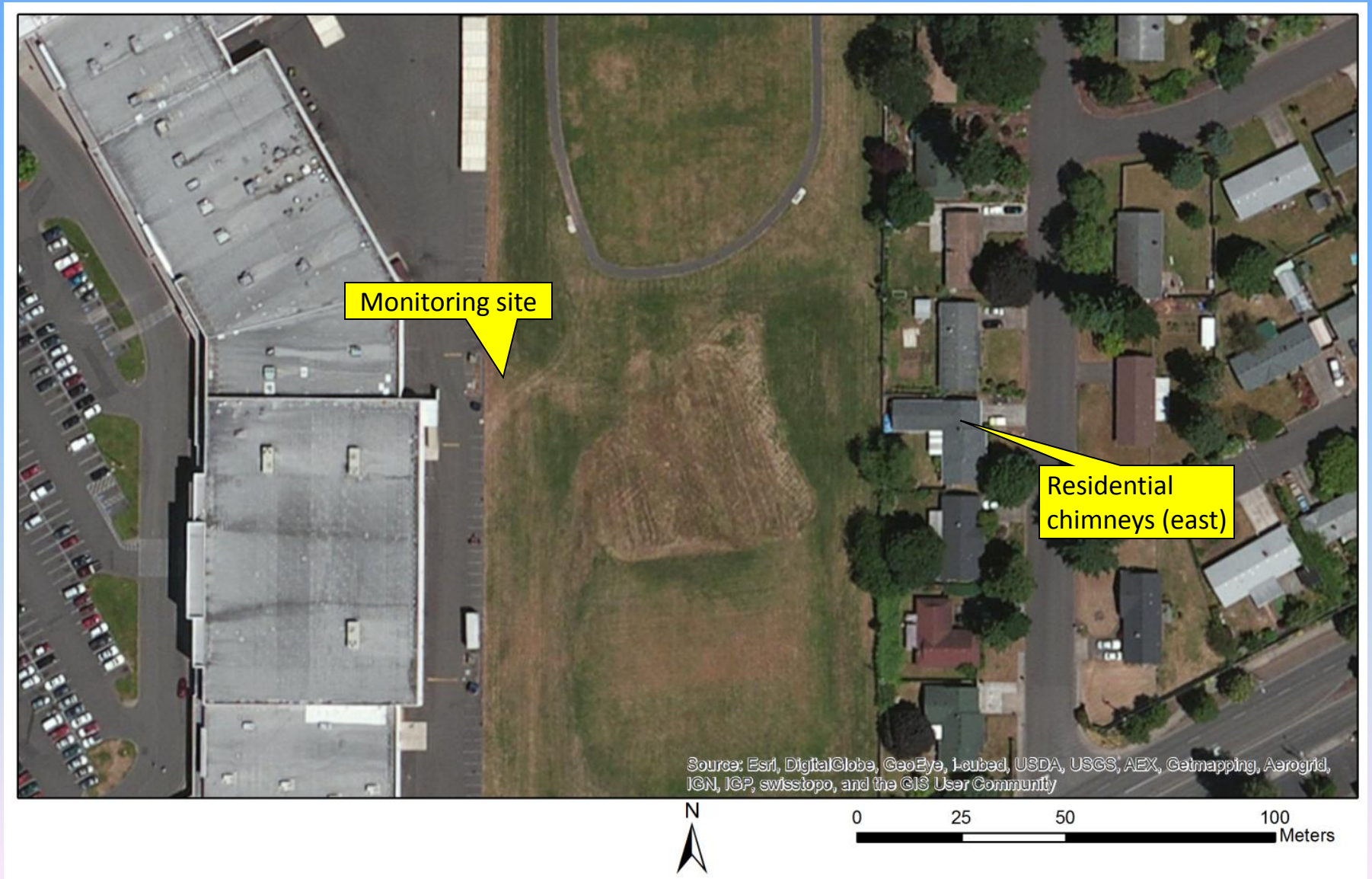
Vancouver $PM_{2.5}$ Concentrations



Nearby Source Impacts



Nearby Source Impacts



What do you do when you have neither time nor money?

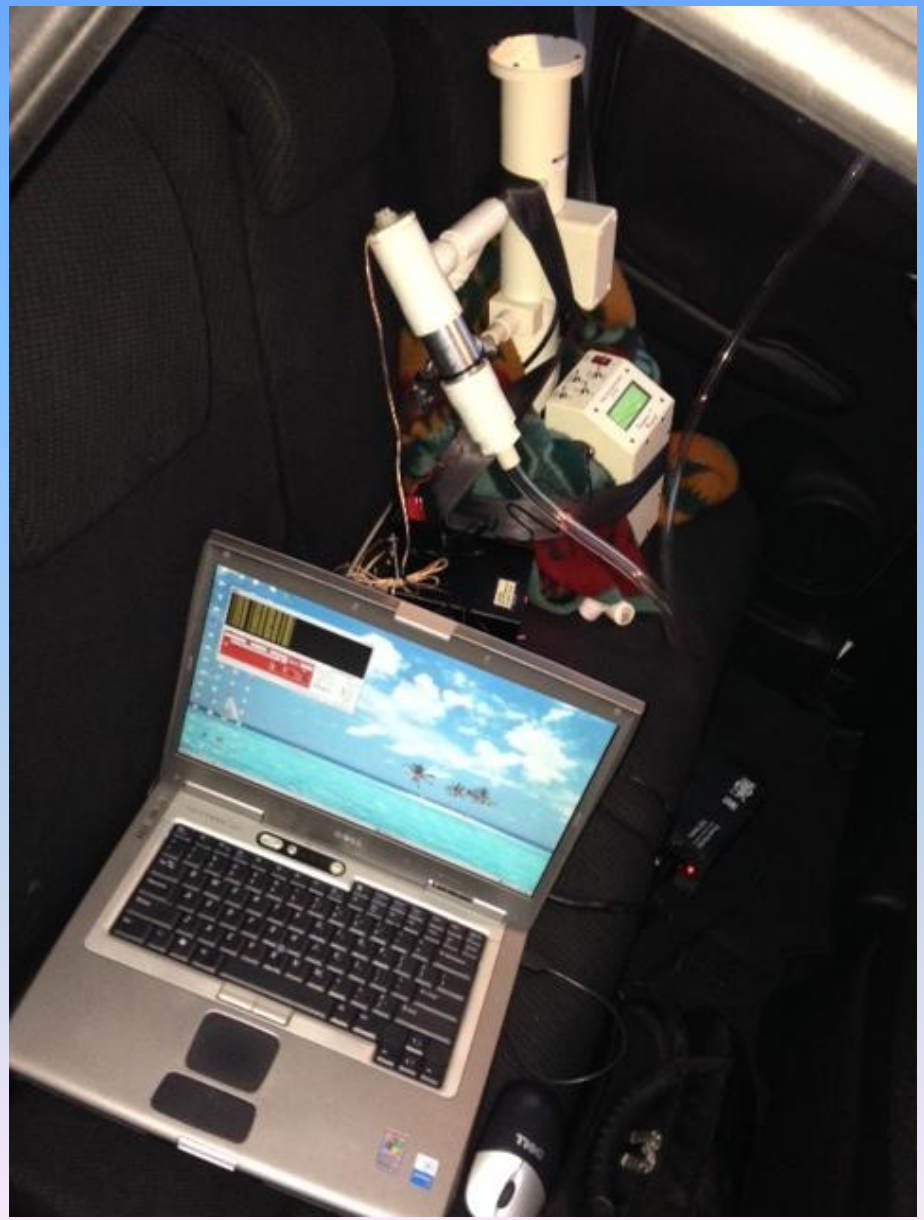
- Study needs:
  - Immediate results
  - Only equipment on hand
  - Wide spatial coverage
  - Minimal temporal variation

…all it takes is a GPS, a nephelometer, two adventurous night-owls, and a pair of pantyhose.

Mobile $PM_{2.5}$ Monitoring Platform

Mobile Nephelometer Platform

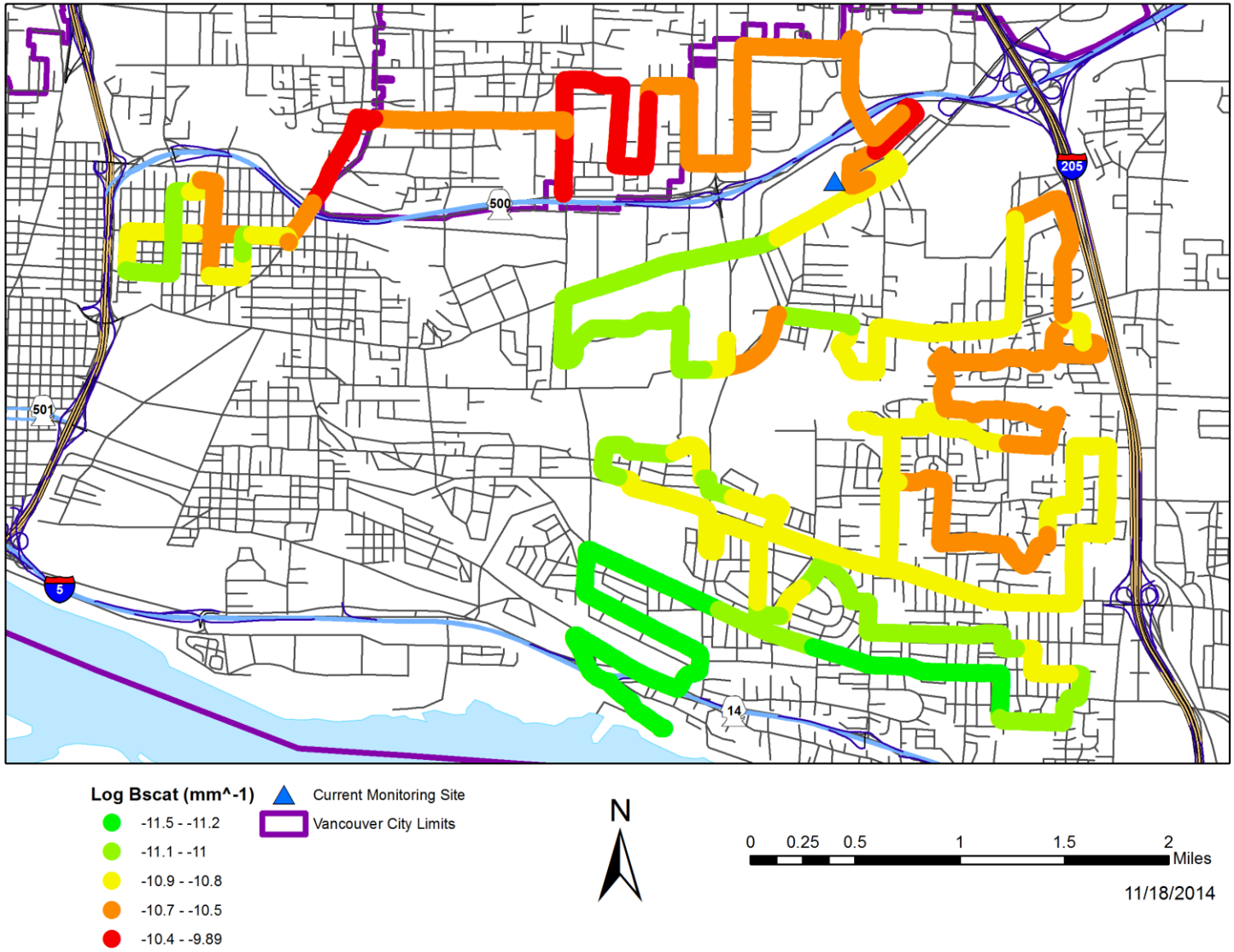
Mobile Nephelometer Platform



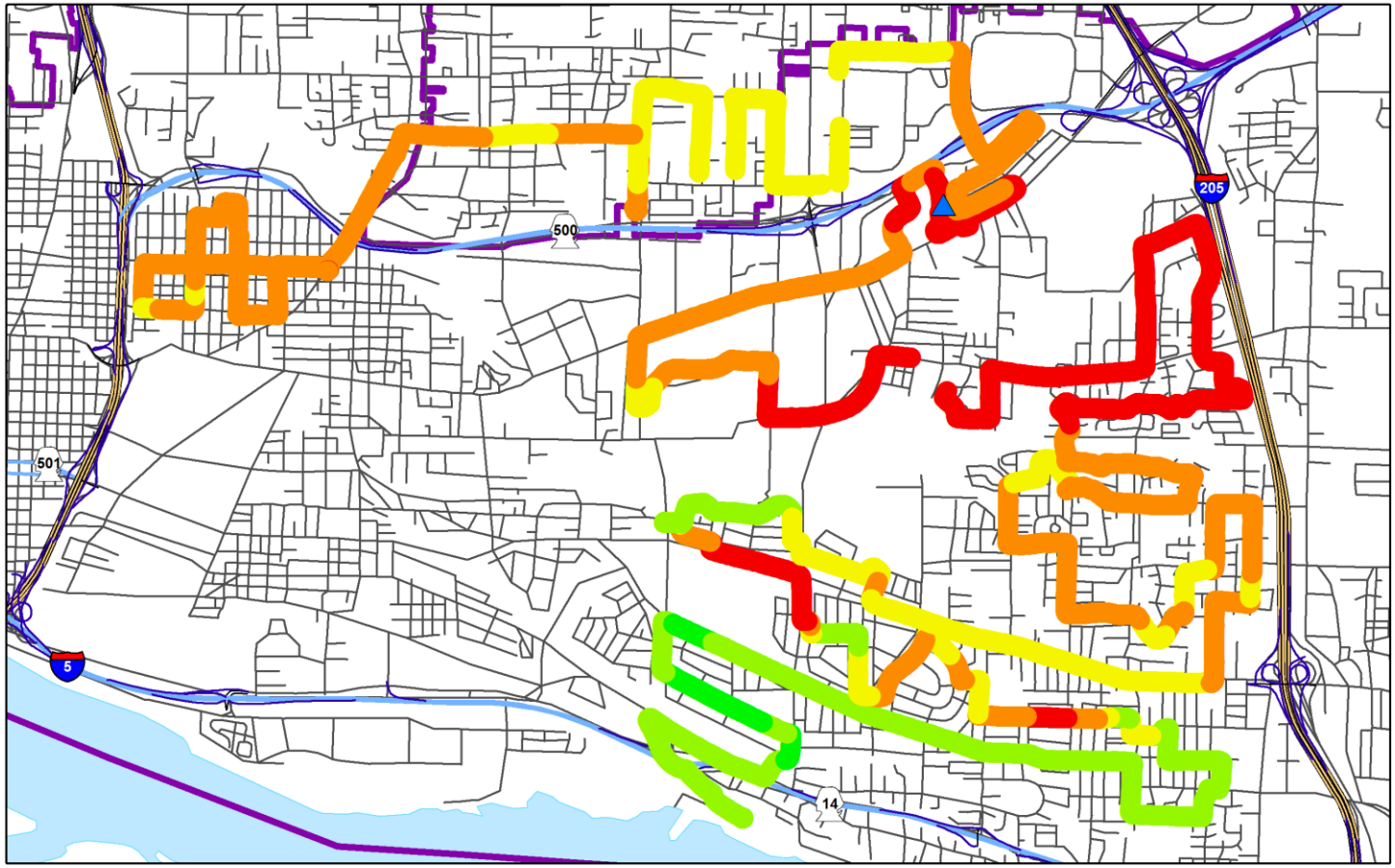
Route Priorities

- ~35 miles (1.5 hours)
- Focus on residential areas with moderate-to-high density of primary wood heating
- Include monitoring site and surrounding neighborhood
- Identify impacts of elevation and distance from Columbia River

Run 1 Results (19:42 – 21:46)



Run 2 Results (23:24 – 1:38)



Log Bscat (mm^-1)

- -11.5 - -11.2
- -11.1 - -11
- -10.9 - -10.8
- -10.7 - -10.5
- -10.4 - -9.89

Current Monitoring Site

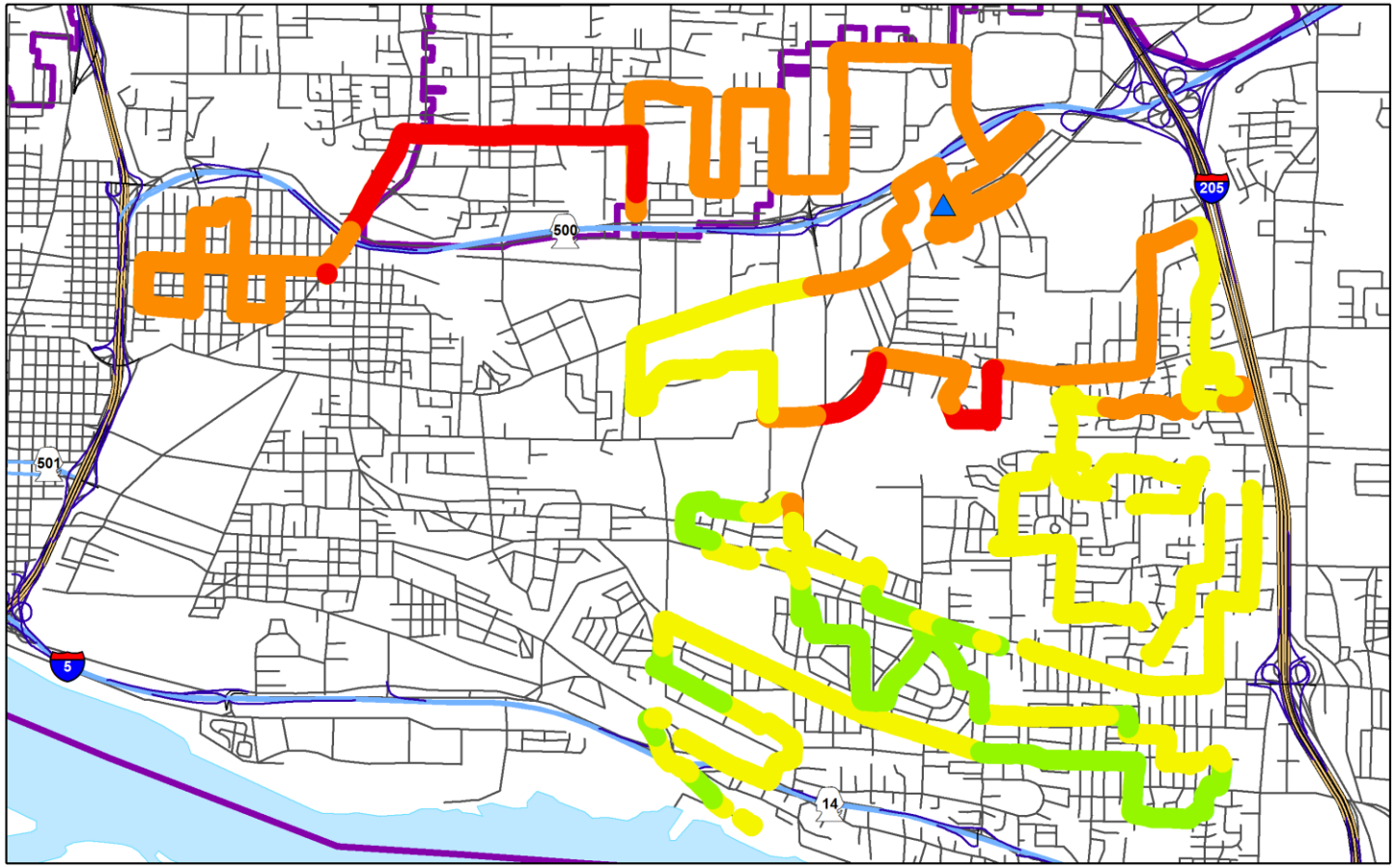
Vancouver City Limits

N

0 0.25 0.5 1 1.5 2 Miles

11/18/2014

Run 3 Results (6:02 – 8:26)



Log Bscat (mm^-1)
-11.5 - -11.2
-11.1 - -11
-10.9 - -10.8
-10.7 - -10.5
-10.4 - -9.89

Current Monitoring Site
Vancouver City Limits

N

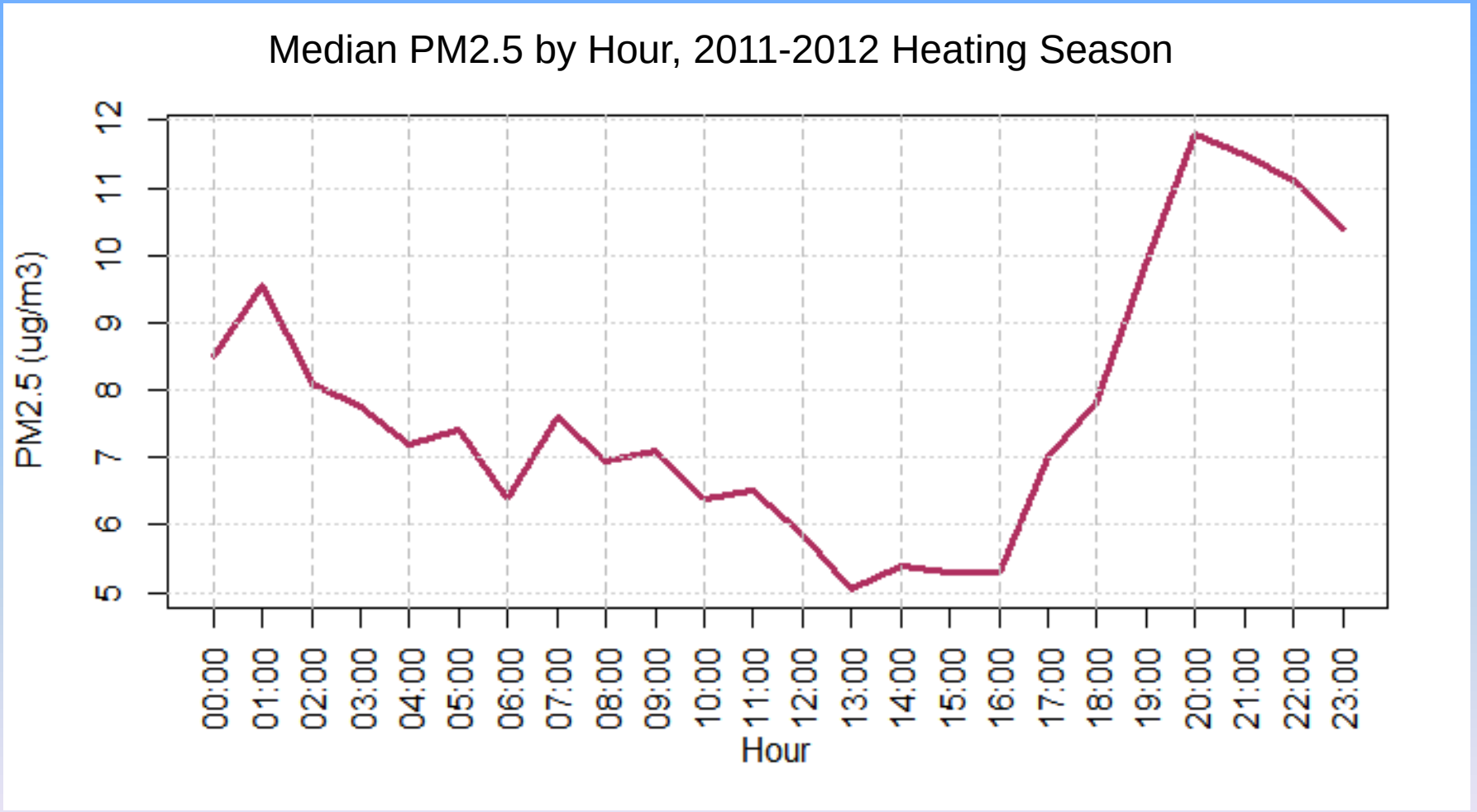
0 0.25 0.5 1 1.5 2 Miles

11/18/2014

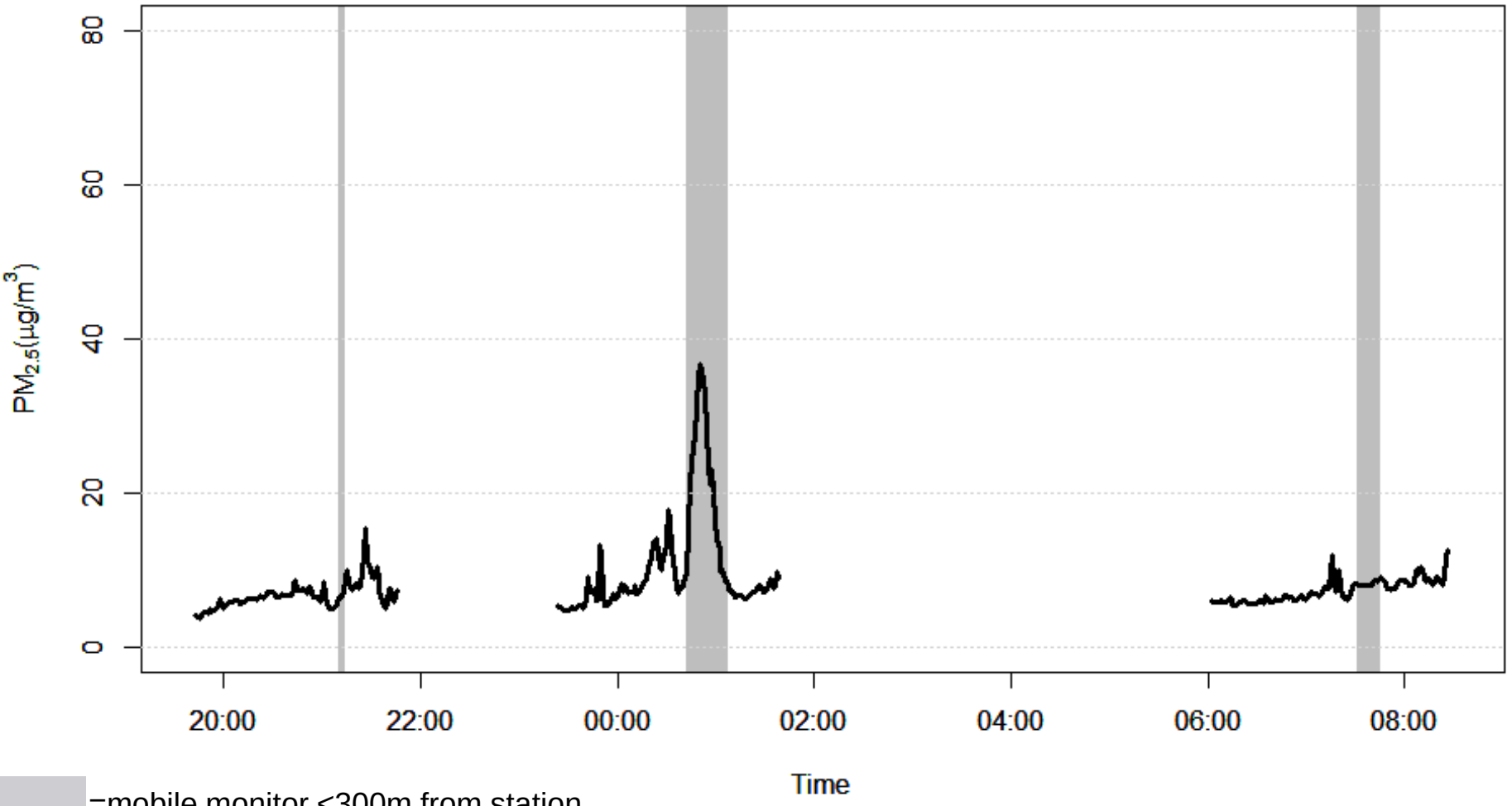
Analysis Method

- Grid of evenly-spaced points 50m apart (fishnet)
- 300 meter buffer around each grid point
- Geometric mean $PM_{2.5}$ within 300 meter buffers (spatial join)
- Ordinary kriging

Typical $PM_{2.5}$ Diurnal Pattern

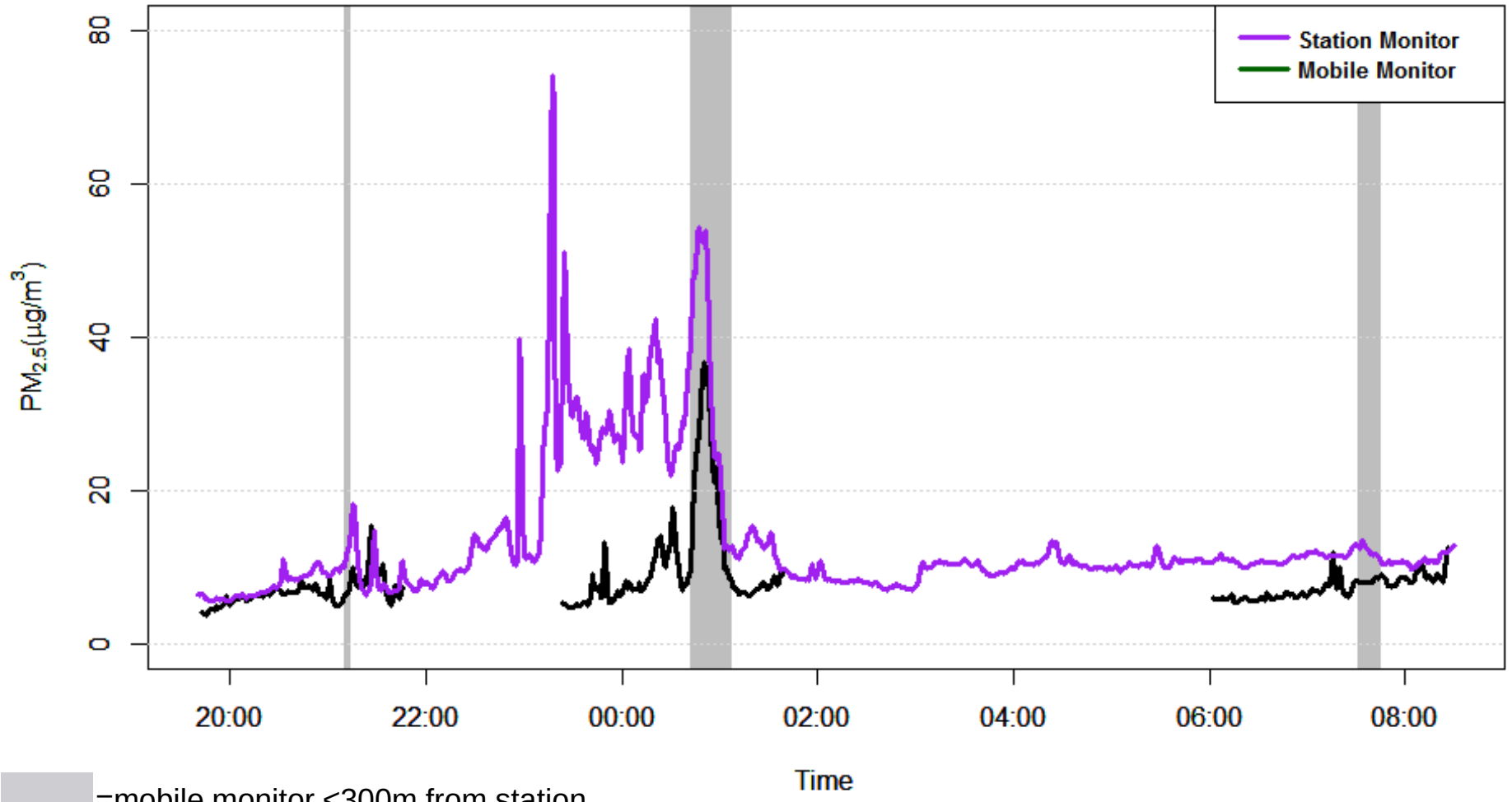


Mobile Monitoring Data Time-Series



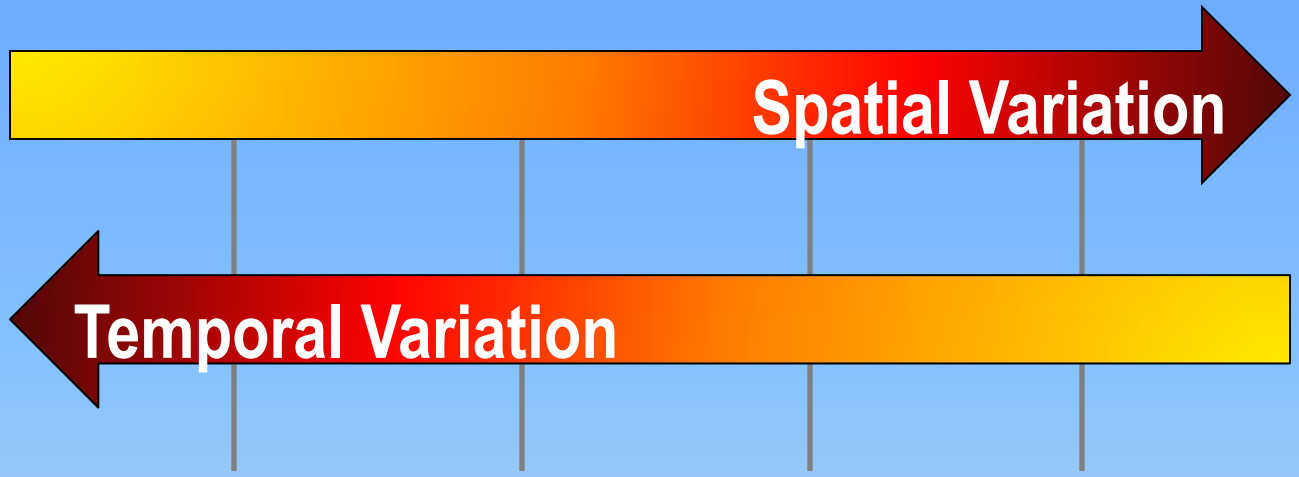
=mobile monitor <300m from station

Mobile/Stationary Monitor Comparison



=mobile monitor <300m from station

Aggregation Strategies

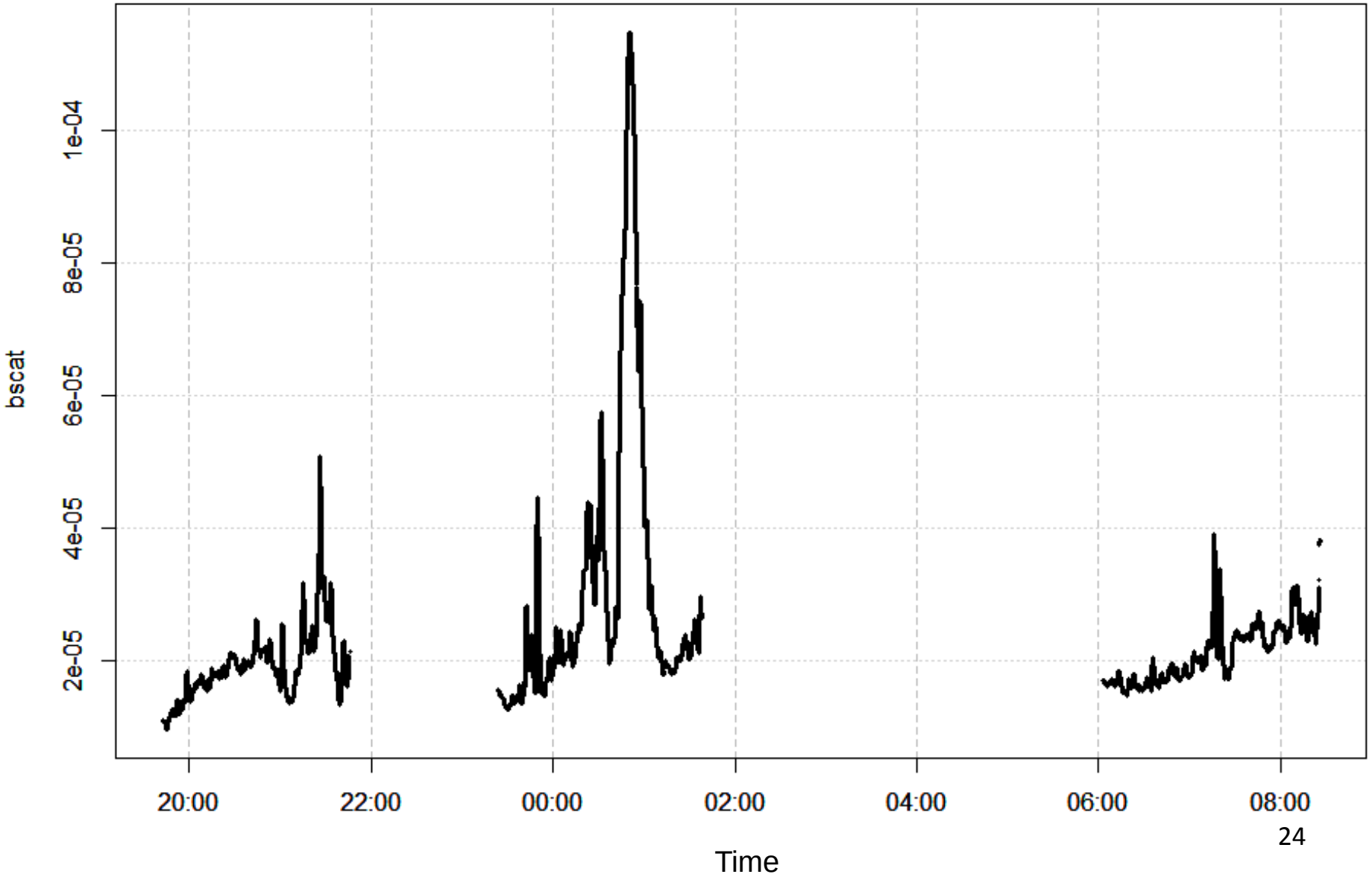


Examples:

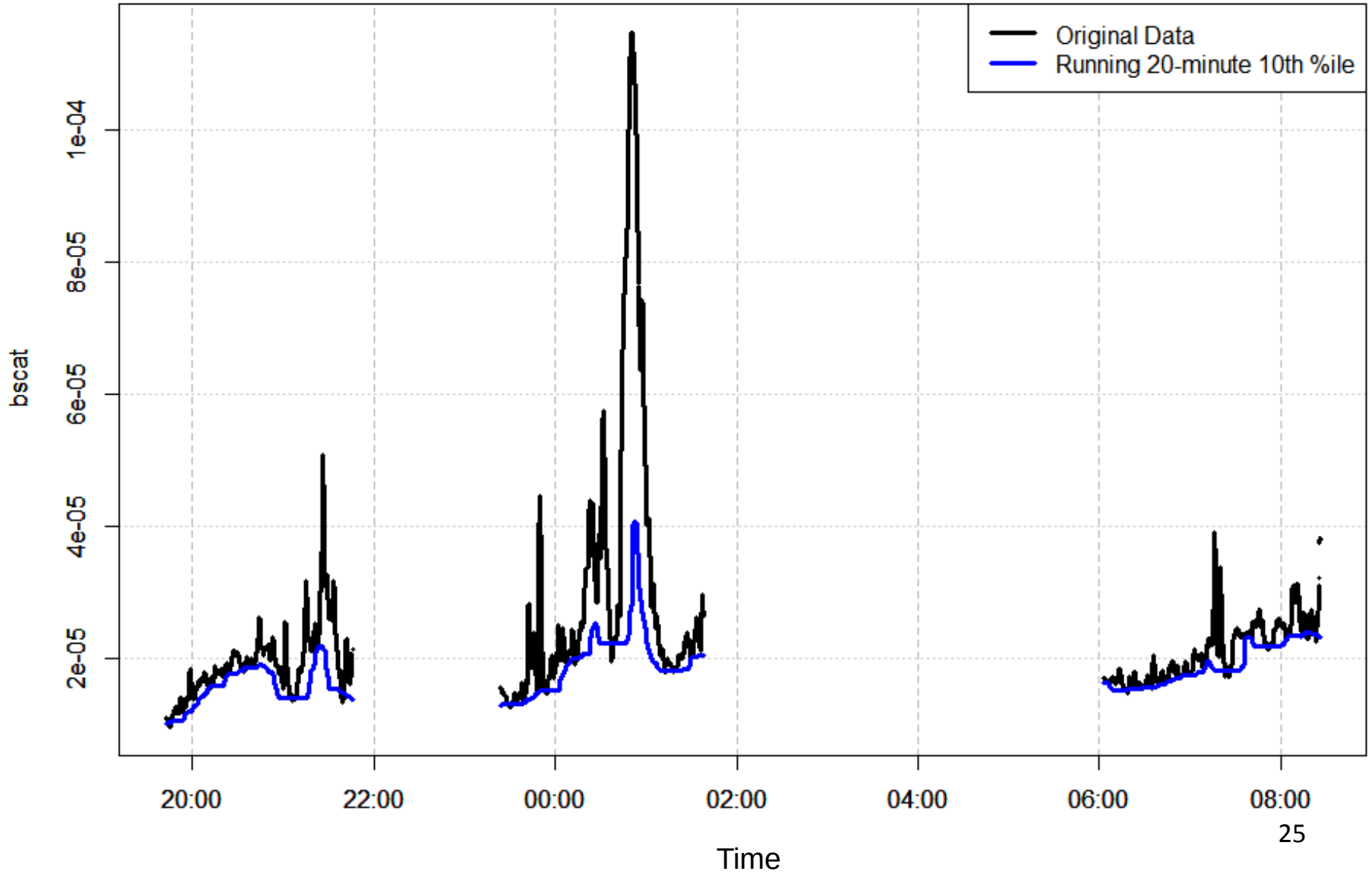
- Subtract temporal variation at “background” site/zone
- Subtract temporal variation at fixed-site monitor
- **Subtract running percentile**

Van Poppel, Martine, Jan Peters, and Nico Bleux. "Methodology for setup and data processing of mobile air quality measurements to assess the spatial variability of concentrations in urban environments." *Environmental Pollution*183 (2013): 224-233.

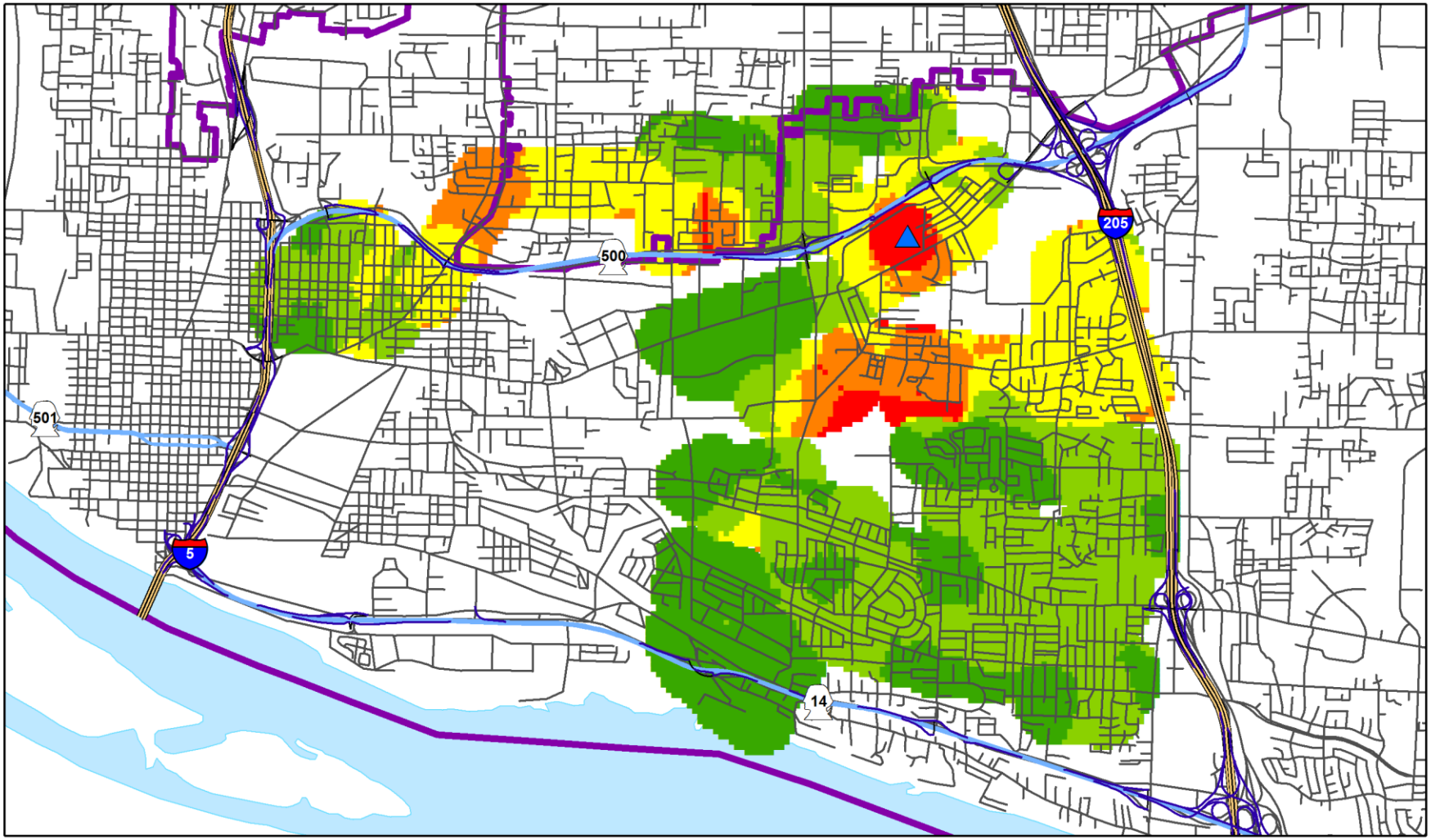
Time-Series of Sampling Results



Time-Series of Sampling Results



Vancouver Mobile Monitoring Results
Above Temporal Background (Running 20-Minute 10th Percentile)



Current Monitoring Sites

Vancouver City Limits

PM2.5 (ug/m^3)

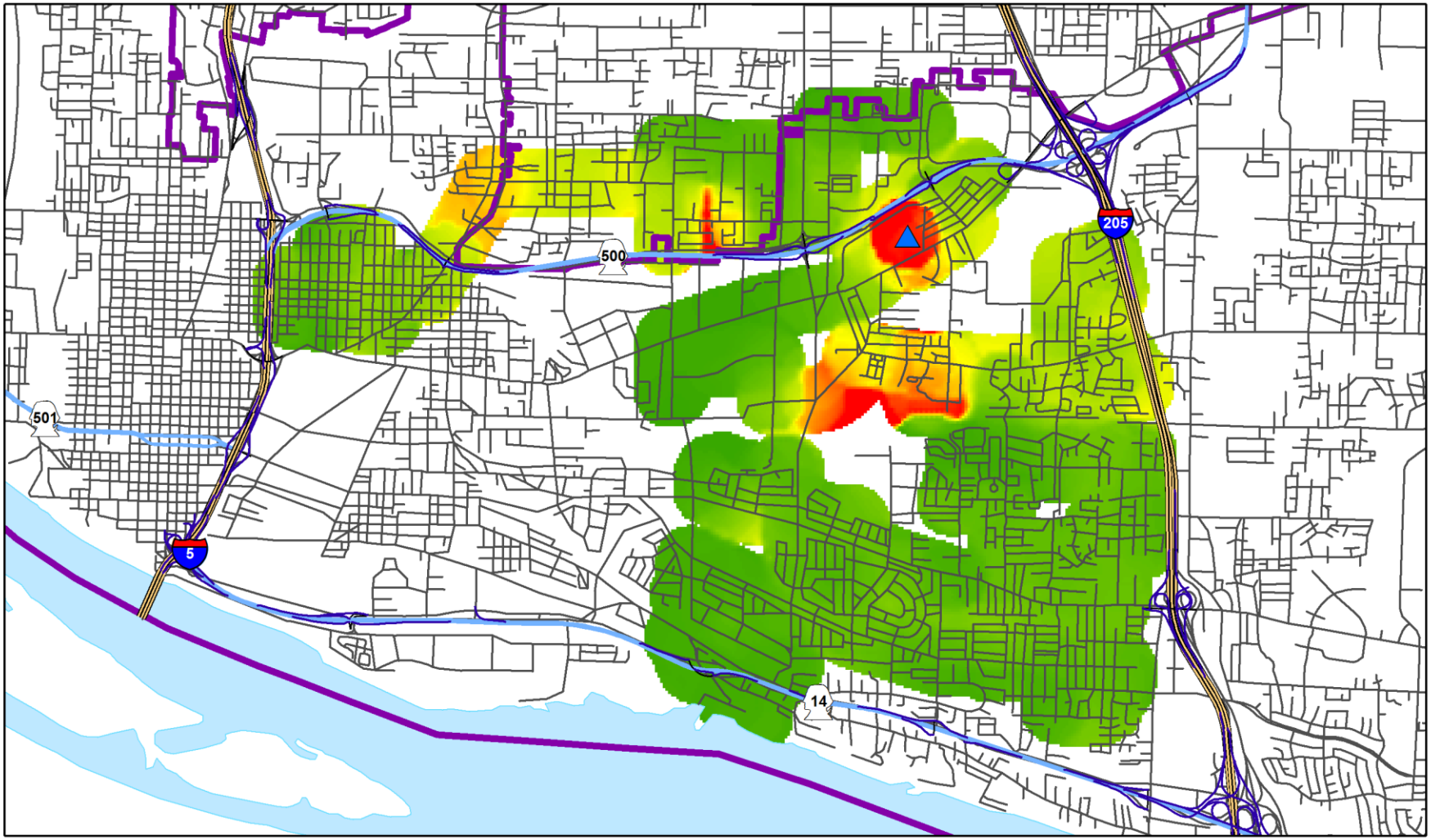
- 0.650 - 1.04
- 1.05 - 1.58
- 1.59 - 2.42
- 2.43 - 3.74
- 3.75 - 11.5

N

0 0.25 0.5 1 1.5 2 Miles

10/22/2014

Vancouver Mobile Monitoring Results
Above Temporal Background (Running 20-minute 10th Percentile)



Current Monitoring Sites

Vancouver City Limits

PM2.5 (ug/m^3)

High : 7.89133

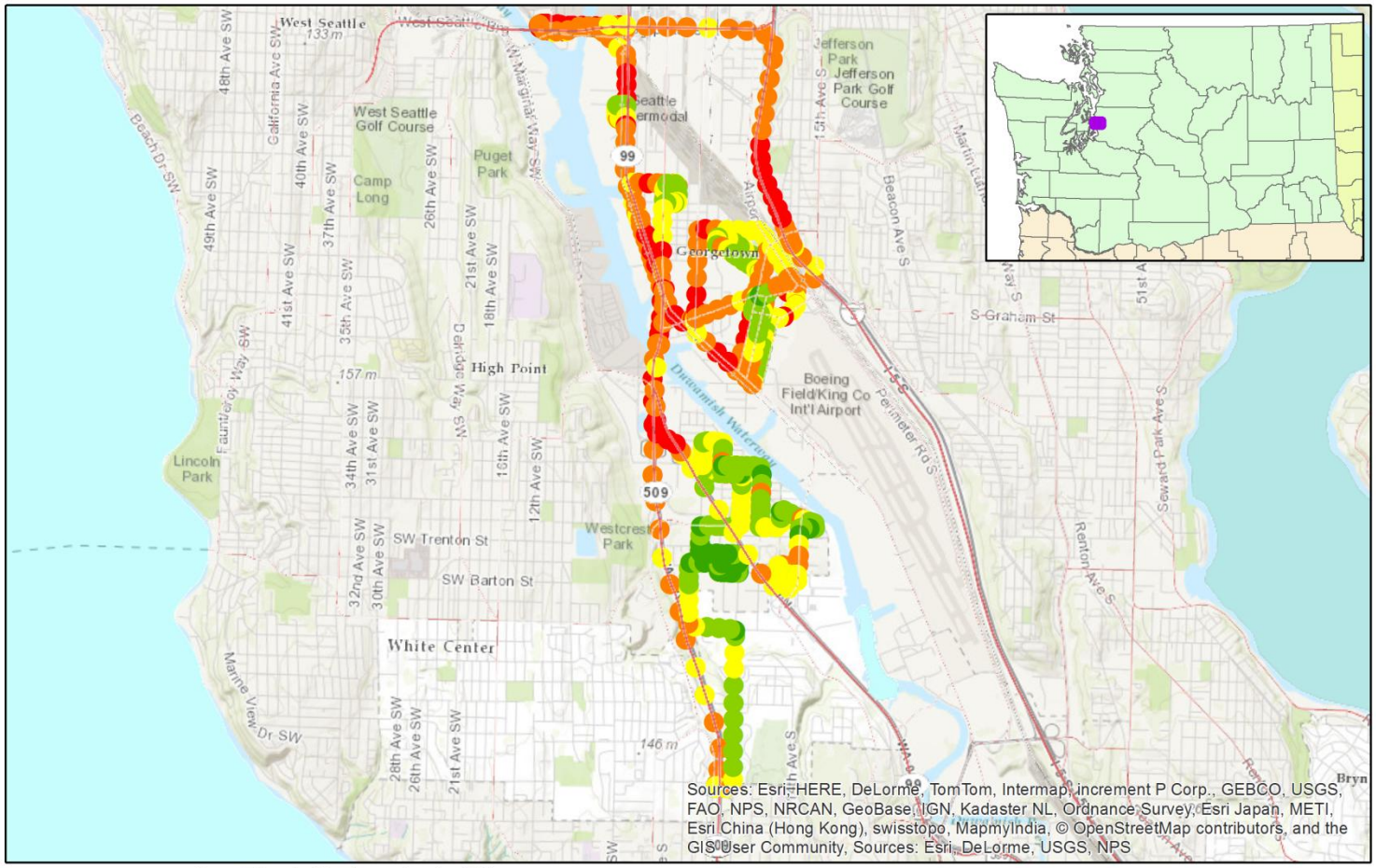
Low : 0.649997

N

0 0.25 0.5 1 1.5 2 Miles

10/22/2014

Seattle Mobile Data



Log Black Carbon (ug/m^3)

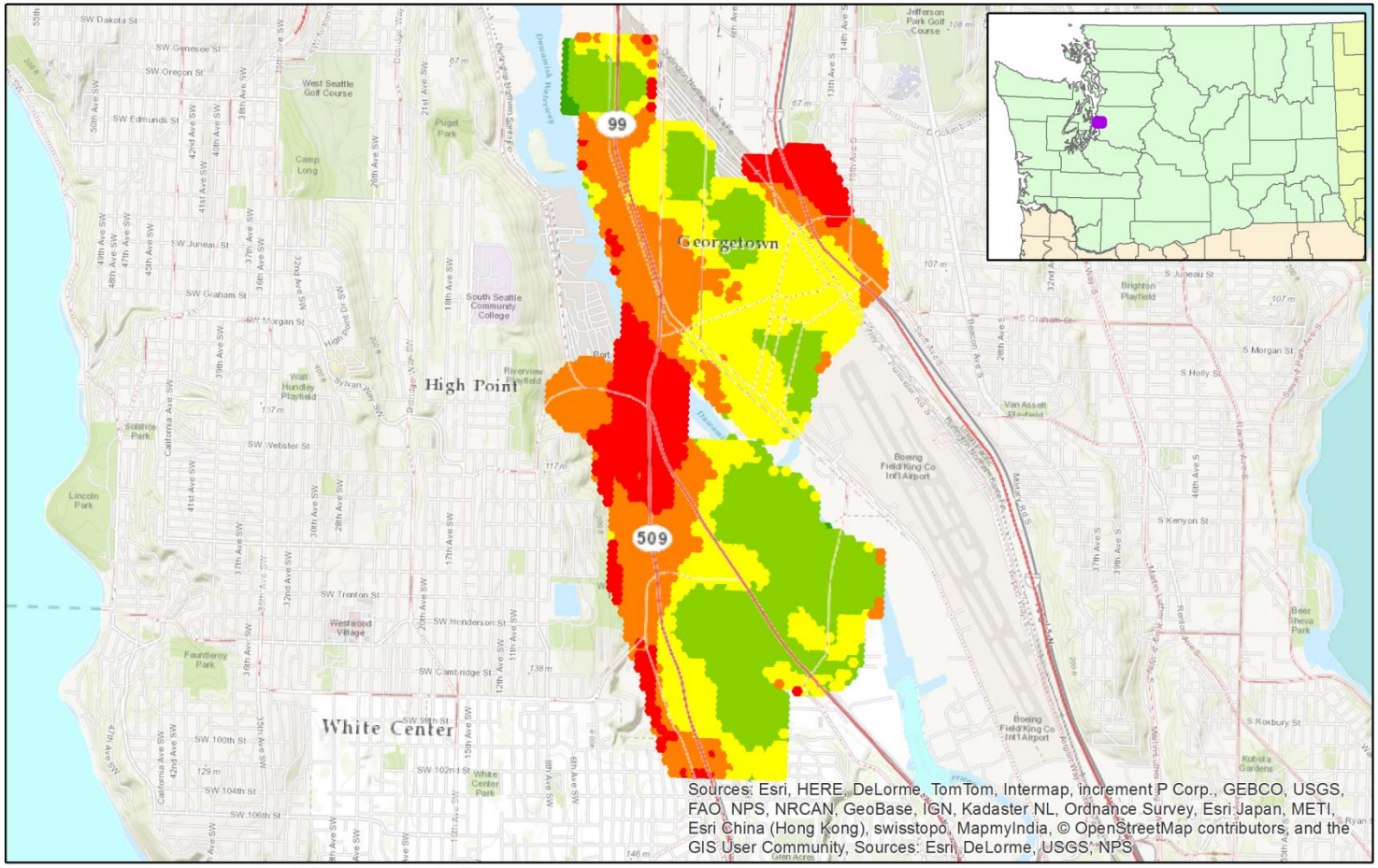
- 1.39 - 5.91
- 5.92 - 6.74
- 6.75 - 7.44
- 7.45 - 8.35
- 8.36 - 11.8

N

0 0.25 0.5 1 1.5 2 Miles

11/18/2014

Seattle Mobile Data



Log Black Carbon (ug/m^3)

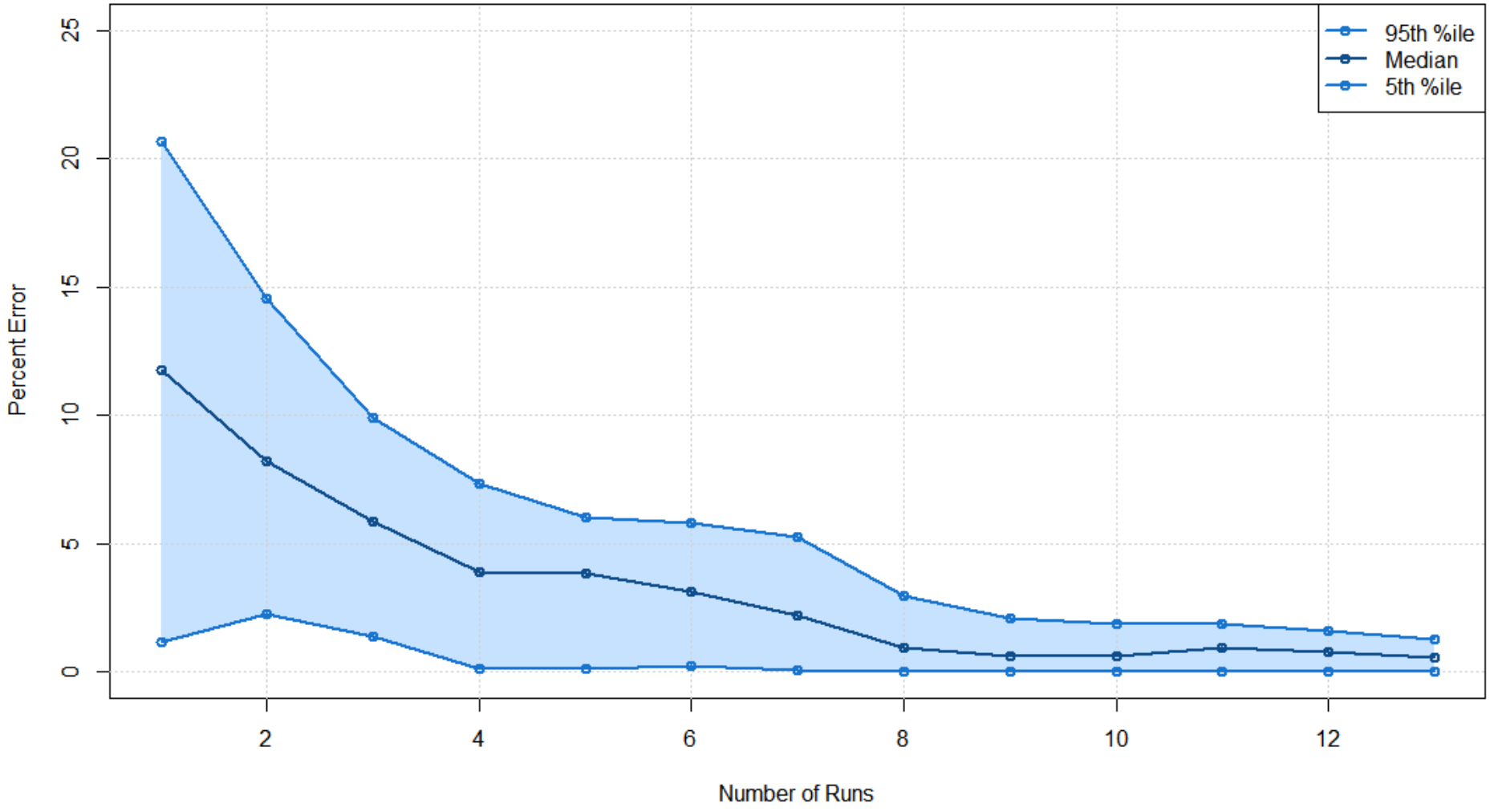
- 1.37 - 2.08
- 2.09 - 3.01
- 3.02 - 3.18
- 3.19 - 3.36
- 3.37 - 3.66

N

0 0.25 0.5 1 1.5 2 Miles

11/18/2014

Percent Error by Run



Recommendations

- Longer stagnation period
- Minimum of 5 runs
- Shorter runs (<1 hour)
- Subtract temporal variation
  - Running percentile (<20th)
  - 20-minute window

Acknowledgements

The Midnight Driving Dream Team
- Cullen Stephenson
- Sean Lundblad

The Statistical Sages
- Assaf Oron
- Ranil Dhammapala

Top Tier Tech Support
- Mike Thompson
- Scott Dubble
- Chuck Pierce
- James Theivagt

Questions?

jill.schulte@ecy.wa.gov